

Mollusca from the sub-recent shell-beds of the lower Swan River,
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INTRODUCTION.

Physiographical and biological investigations in the Eastern States of Australia* have shown that climatic changes have occurred in very late geological times.

In this paper it is proposed to adduce evidence that in almost recent times, the sea washing the south-western shores of Australia was considerably warmer than it is now. At the same time it must be clearly understood that a great deal of material evidence along the lines followed by the writer has yet to be collected and analysed, and it is probable that further work may weaken the case for a recent cooling in ocean temperatures.

Papers read before this society have drawn attention to evidence, in the form of raised beaches, river terraces, etc., of recent uplift to the extent of twenty or thirty feet in the country bordering on the lower Swan and Helena Rivers.†

Arousseau and Budge mention that the climate before the movements described was warmer than it is now, indications of this fact being obtained from "the older Perth Shell Banks, and the younger Rottneest Shell Banks." The evidence for this statement was that a number of molluscan species, collected by Dr. Simpson and identified by Mr. C. Hedley, have not, so far, been

*Howchin, W.: The recent extension of certain marine animals on the southern coast of Australia, together with other facts that are suggestive of a change in climate. Rep. 16th Meeting, Austr. Ass. Adv. Sci., Wellington, 1923, p. 94.

†Somerville, J. L. Evidences of uplift in the neighbourhood of Perth: Jour. and Proc. Roy. Soc. W.A., vol. vi., pt. I, pp. 5-29, 1919.

Arousseau, M. and Budge, E. A.: The terraces of the Swan and Helena Rivers and their bearing on recent displacement of the strand line. Jour. and Proc. Roy. Soc., W.A., vol. vii., pp. 24-43, 1920.

found living in the Swan river, but are recorded from warmer waters farther north.

Dr. Simpson and Messrs. H. P. Woodward and M. Auroiseau sent collections from the various shell beds to the British Museum, and to the Australian Museum, Sydney, in 1920. The work of identification was done in the latter case by Messrs Hedley and R. W. Brettnall, but there is no information regarding the author of this work in the British Museum. Dr. Simpson presented the lists from these two sources, together with some named species, to the Department of Geology, University of Western Australia. Later Messrs. J. L. Somerville and J. Cummins collected shells from the beds, and sent some species to Mr. F. Chapman, of the National Museum, Melbourne, for identification. The species so named are also in the collection of the Department of Geology. The writer has been collecting from Minim Cove, and Peppermint Grove, this work forming a portion of his course in Geology, at the University of W.A., and in addition to securing many specimens of the species previously recognised, he has found several species new to the district, for aid in the identification of which he is indebted to Mr. L. Glaupert, of the Perth Museum.

The main difficulty experienced in this work has been the paucity of literature on the mollusca of this State. Hedley's paper to this Society has proved of great assistance.* Apart from this source, information regarding range has been derived from various papers in the Proceedings of the Linnean Society of New South Wales, and the Royal Societies of Queensland and South Australia. The writer also wishes to acknowledge the interest shown in his work by Sir Joseph Verco and Mr. Hedley.

It is hoped that this contribution, besides summarising the present knowledge of the sub-recent fossils of the lower Swan River District, will lead to further work on the problem of Quaternary climates in this region.

*C. Hedley: Preliminary index of the mollusca of Western Australia, Jour. and Proc. Roy. Soc., W.A., vol. i., pp. 152-226, 1914.

LIST OF SPECIES WITH LOCALITIES.

Abbreviations.

Initial after name of species indicates person responsible for identification.

C.—Mr. F. Chapman.

M.—British Museum, and Mr. R. W. Brettnall, of Australian Museum.

R.—Mr. L. Glauert, Perth Museum and the writer.

Initial after locality indicates collector.

R.—J. Cummins, J. L. Somerville and the writer.

S.—Dr. E. S. Simpson, and Messrs. M. Arousseau and H. P. Woodward.

Letter following specific localities indicates relative abundance.

r.—rare.

m.c.—moderately common.

c.—common.

x.—relative abundance not noted.

(p. 150)—Page in Hedley's Catalogue (op. cit.) "Recorded from" means "recorded living from."

Sub-kingdom MOLLUSCA.

Class LAMELLIBRANCHIATA (Pelecypoda).

Order, PRIONODESMACEA.

Arca trapezia, Deshayes (C.) *Localities*—Peppermint Grove (r.) and Minim Cove (m.c.), [R.]. *Recorded from* Sydney, North-West Australia and New Guinea.

Arca fusca, Reeve (M.). *Locality*—Fremantle (x.) [S.]. *Recorded from* Cossack, Monte Bello Is., New Guinea, Thursday Island, Cleveland Bay and Murray Is. (p. 154).

Arca scapha, Chemnitz (M.). *Locality*—Peppermint Grove (m.c.), and Minim Cove (m.c.), [S.].

Arca granosa, Linn (M.). *Locality*—Fremantle (x.)

Pinna virgata, Menke (C.). *Localities*—Peppermint Grove (r.) and Minim Cove (r.), [R.], (p. 155.)

Pinna phillipinensis, (M.). *Locality*—Minim Cove (r.), [S.]

Ostrea angasi, Sowerby (M.). *Localities*—Peppermint Grove (m.c.) and Minim Cove (m.c.), [R.], Perth Water (c), Melville Water (c), Canning Canal (c), Fremantle (x.) [S.]. *Recorded from* King George's Sound.

Ostrea cf. cucullata, Born (C.). *Localities*—Peppermint Grove (r.), Minim Cove (r.), [R.]. *Recorded from* King George's Sound and Monte Bello Island.

Diplodon, sp. (M.) [cf. *D. ambiguus* or *Unio ambiguus*—Hedley, p. 156]. *Localities*—Peppermint Grove (r.), and Minim Cove (r.), [S.]. *D. ambiguus* recorded from Canning River.

Chlamys asperimus, Lamarek (M.). *Localities*—Perth Water (r.), Melville Water (r.), Canning Canal (r.), [S.]. *Recorded from* Swan R., Dirk Hartog, Exmouth Gulf.

Pecten medius, Lamarek (M.). *Localities*—Perth Water (r.), Melville Water (r.), [S.]. (p. 157.)

Pecten dringi, Reeve, (M.). *Locality*—Peppermint Grove (x.), [S.].

Brachyodontes erosus, Lamarek (M.). *Locality*—Rottneest (r.), [S.]—(cf. *Mytilus*.) *Recorded from* Rottneest, Carnae Island, Garden Island, Geraldton and King George's Sound (p. 158).

Modiola, spp. (R.). *Localities*—Peppermint Grove (r.), Minim Cove (r.), Canning Canal (r.), [R.], (p. 159.)

Mytilus sulcatus, Lamk. (?), (M.). *Locality*—Minim Cove (r.), [S.], (p. 159).

Mytilus latus, Lamarek (M.). *Locality*—Minim Cove (r.), [S.], (p. 159).

Katelsysia strigosa, Lamarek (C.). *Locality*—Peppermint Grove (e.), and Minim Cove (e.), [R.].

Katelsysia scalarina, Lamarek (C.). *Localities*—Peppermint Grove (e.), and Minim Cove (e.), [R.].

Order TELEODESMACEA.

Crassatellites kingicola, Lamarek (M.). *Locality*—Minim Cove (x.), [S.]. *Recorded from* Woodman's Point and Cossack (p. 160.)

Cardita, sp. (M.). *Locality*—Rottneest (x.), [S.], (p. 160).

Cardita, sp. (M.). *Locality*—Melville Water (e.), [S.]. Mr. Hedley notes that this does not correspond to any recorded W.A. form and is probably a new species.

Cardium rugatum, Dillwyn (M.). *Locality*—Perth Water (e.), [S.]. (? *C. erugatum*, Tate). *Recorded from* Monte Bello Is. (p. 162).

Cardium tenuicostatum, Lamarek (M.). *Locality*—Perth Water (r.), [S.]. *Recorded from* Tasmania (p. 163.)

Cardium vertebratum, Jonas (M.). *Locality*—Minim Cove (x.), [S.].

Cardium, sp. (C.). *Locality*—Minim Cove (r.), [R.]. Mr. Chapman notes that this is probably a new species resembling *C.*

exasperatum, but more oblique. *C. exasperatum* is recorded from Swan River.

Cardium unedo, Linne (R.). *Locality*—Minim Cove (r.), [R.]. *Recorded from* Monte Bello Is. and Thursday Is. (p. 163.)

Cardium, sp. (R.). *Locality*—Minim Cove (r.), [R.].

Soletellina biradiata, Wood (C.). *Locality*—Minim Cove (r.), [R.]. *Recorded from* King George's Sound (p. 167.).

Chama limbula, Lamarek (M.). *Locality*—Peppermint Grove (r.), Minim Cove (r.), Perth Water (c.), Melville Water (c.), Canning Canal (c.), [S.]. *Recorded from* North-West Australia (p. 161).

Chama nivalis, (M.). *Locality*—Minim Cove (x.), [S.].

Chama asperella, Lamarek (M.). *Locality*—Melville Water (x.), [S.]. *Recorded from* Sharks Bay.

Chama, sp. (M.). *Locality*—Fremantle (x), [S.].

Cryptodon globularis, Lamarek (M.). *Locality*—Minim Cove (x.), [S.]. *Recorded from* King George's Sound (p. 162.)

Lasea australia, Lamarek (C.). *Locality*—Minim Cove (r.), [R.]. *Recorded from* Geraldton, Timor and King George's Sound (p. 162.)

Dosinia lucinalis, Lamarek (M.). *Locality*—Peppermint Grove (c.), Minim Cove (c.), Perth Water (m.c.), and Rottnest (x.). *Recorded from* Monte Bello Is. (p. 163.)

Dosinia sculptilis, Hanley (M.). *Localities*—Perth Water (r.), Melville Water (r.), [S.].

Dosinia, sp. A. (C.). *Locality*—Minim Cove (x.), [R.]. (Deep sub-trigonal outline and small sharp umbos separate this from known living species—C.)

Dosinia, sp. B. (C.). *Locality*—Minim Cove (x.), [R.]. (Smaller heavier build. Between *D. africana*, Gray and *D. brughieri* Gray. Smaller than the latter—found in Swan R.—and has less strongly developed ornament—C.)

Divaricella, sp. (C.). *Locality*—Minim Cove (x.), [R.] (p. 161.)

Gafrarium sulcatum, Gray (M.). *Localities*—Peppermint Grove, Minim Cove, Melville and Perth Waters (c.), [S.].

Marcia peronii, Lamarek (M.). *Locality*—Rottnest (x.), (p. 164.)

Marcia, sp. (C.). *Locality*—Minim Cove (c.) [R.].

Paphia euglypta, Phillipi (M.). *Localities*—Perth Water, Melville Water, Canning Canal (m.c.), [S.], (p. 164.)

Paphia tapes, (C.). *Locality*—Minim Cove (m.c.), [R.], (p. 164.)

- Paphia**, sp. (R.). *Locality*—Minim Cove (r.), [R.].
- Venus (Antigona) laqueata**, Sowerby [C.]. *Locality*—Fremantle (x.), (p. 165.)
- Venus (Chione) strigosa**, Lamarek [C.]. *Locality*—Minim Cove (x.), [R.]. (Tate records this species living from King George's Sound).
- Venus (Chione) scalarina**, Lamarek [C.]. *Locality*—Minim Cove (x.), [R.]. (Tate records this species living from King George's Sound).
- Venus**, sp. [R.]. *Locality*—Minim Cove (r.), [R.].
- Venerupis carditoides**, Lamarek [M.]. *Localities*—Perth Water and Melville Water (r.), [S.]. *Recorded* from Swan R. and Tasmania (p. 166.)
- Venerupis planicosta**, Deshayes [M.] *Locality*—Rottneſt (x.), [S.]. *Recorded* from Swan R. and Tasmania.
- Tellina deltoidalis**, Lamarek [M.]. *Locality*—Peppermint Grove and Minim Cove (c.), [S.]. *Recorded* from Tasmania.
- Tellina perna**, Spengler (C.). *Localities*—Minim Cove and Peppermint Grove (c.), [R.] *Recorded* from Sharks Bay, Geraldton, Monte Bello Is.
- Tellina**, sp. (C.). *Locality*—Minim Cove (m.c.), [R.]. (Near *T. aldingensis*, Tate. This has shorter anterior and more rounded posterior umbonal margin than Tate's species.—C.)
- Tellina**, sp. (C.). *Locality*—Minim Cove (r.), [R.]. Apparently ancestral to *T. deltoidalis* shorter with inflated valves—C.)
- Tellina**, spp. [R.] *Locality*—Peppermint Grove and Minim Cove (c.), [R.]. (Two species to be determined).
- Macoma**, sp. [M.]. *Locality*—Peppermint Grove and Minim Cove (m.c.), [S.].
- Lucina (Codakia) cf. simplex**, Reeve [C.]. *Locality*—Minim Cove (r.), [R.]. *Recorded* from North Australia.
- Amphidesma praecisa**, Reeve [M.]. *Locality*—Rottneſt (x.), [S.]. *Recorded* from King George's Sound, (p. 169.)
- Saxicava australis**, Lamarek [M.]. *Locality*—Melville Water (r.), [S.]. *Recorded* from Cossack, (p. 169.)
- Nausitoria saulli**, Wright (M.). *Locality*—Rottneſt (x.), [S.]. *Recorded* from Fremantle and Tasmania, (p. 170.)

Class, GASTEROPODA.

Order, DIOTOCARDIA.

Clanculus denticulatus, Gray (M.). *Locality*—Perth Water (r.), [S.]—cf. *Trochus lupinus*, Philippi. *Recorded from Geraldton*, (p. 177.)

Cantharidus nitens, Kiener (M.). *Locality*—Rottnest (x.), [S.], (p. 178.)

Cantharidus cf. **conicus**, Gray (C.). *Locality*—Peppermint Grove and Minim Cove (x.), [R.]. *Recorded from Geraldton* (p. 179.)

Cantharidus, sp. (R.). *Locality*—Peppermint Grove and Minim Cove (x.), [R.].

Cantharidus pulcherrimus, Wood (C.). *Locality*—Peppermint Grove and Minim Cove (x.), [R.]. *Recorded from Geraldton*, (p. 179.)

Monilea lentigenosa, A. Adams (M.). *Locality*—Perth and Melville Waters (r.), [S.]. *Recorded from Swan R. and Sharks Bay*, (p. 180.)

Calliostoma, sp. [M.]. *Locality*—Melville Water (r.), [S.], (p. 180.)

Cyclostrema tatei, Angas (M.). *Locality*—Peppermint Grove and Minim Cove (c.), [S.]. *Recorded from Geraldton*, (p. 182.)

Liotina, sp. (M.). *Locality*—Perth Water and Melville Water (c.), [S.], (p. 182.)

Liotia, sp. [M.]. *Locality*—Peppermint Grove and Minim Cove (m.c.), and Perth Water (r.), [S.].

Turbo pulcher, Menke [C.]. *Locality*—Minim Cove (x.), Fremantle (x.), [R.]. *Recorded from Geraldton*, (p. 181.)

Turbo, spp. [R.]. *Locality*—Peppermint Grove and Minim Cove (c.), [R.]. (Two species to be determined.)

Patelloidea connoidea, Quoy and Gaimard (M.). *Locality*—Rottnest (x.), [S.]. *Recorded from King George's Sound and Ellensbrook*, (p. 184.)

Patelloidea altricostata, Angas (M.). *Locality*—Minim Cove and Fremantle (x.), [S.]. *Recorded from King George's Sound, Ellensbrook, Yalingup, Esperance Bay.*

Acmea aculeata, Reeve (M.). *Locality*—Fremantle (x.), [S.].

Acmea scalarina, Cox sp. (M.). *Locality*—Peppermint Grove and Minim Cove (x.), [S.]. *Recorded from Geraldton* (p. 188.)

Patella zebra, Reeve (M.). *Locality*—Fremantle (x.), (p. 185.)

Order, MONOTOCARDIA.

Bembicium melanostoma, Gmelin (M.). *Locality*—Minim Cove and Rottneest (x.), [S.]. (*Trochus*—*Rissella*), (p. 187.)

Obtortio lutosus, Hedley (C.). *Locality*—Peppermint Grove and Minim Cove (m.c.), Perth and Melville Waters (e.), [R.]. *Recorded from* Sydney and Hope Is., Q.

Rissoina sp. (C.). *Locality*—Minim Cove (r.), [R.], (p. 187.)

Bullinella arachis, Q. & G., (C.). *Locality*—Minim Cove (x), [R.]. *Recorded from* King George's Sound.

Diala lauta, A. Adams (M.). *Locality*—Peppermint Grove and Minim Cove (m.c.), [S.]. *Recorded from* King George's Sd. and Geraldton, Port Adelaide and Tasmania, (p. 188.)

Diala translucida, Hedley (C.). *Locality*—Minim Cove (x.), [R.]. *Recorded from* N.S.W., (p. 188.)

Diala, sp. (M.). *Locality*—Perth and Melville Waters (e.), [S.].

Hipponix antiquata, Linne (M.). *Locality*—Fremantle (x.), [S.]. *Recorded from* Geraldton, (p. 189.)

Alaba, sp. (M.). *Locality*—Perth and Melville Waters (m.c.), [S.]—**A. vitex**, Adams—*recorded from* Sharks Bay.)

Assemania granum, Menke (M.). *Locality*—Peppermint Grove (r.), [S.]. (—*Paludina*). *Recorded from* Swan R., (p. 188.)

Clava fasciata, Brughiere (M.). *Locality*—Peppermint Grove (m.c.), [S.]. *Recorded from* Monte Bello Is. and Irwin R., (p. 190.)

Bittium granarium, Kiener (M.). *Locality*—Peppermint Grove and Minim Cove (m.c.), [S.]. (—*Cerithium*.) *Recorded from* Geraldton and Tasmania.

Bittium cerithium, Q. & G. (M.). *Locality*—Peppermint Grove and Minim Cove (e.), [S.].

Bittium estuarinum, Tate (M.). *Locality*—Minim Cove and Rottneest (x.), [S.]. (Apparently new to W.A.—M.)

Bittium, sp. (R.). *Locality*—Peppermint Grove and Minim Cove (m.c.), [R.].

Cerithium, sp. (R.). *Locality*—Peppermint Grove (m.c.), Minim Cove (e.), [R.], (p. 190.)

Cerithium tuberculatum, Linne (M.). *Locality*—Minim Cove (x.), [S.].

Polinices (Natica) strangei, Reeve (M.). *Locality*—Peppermint Grove and Minim Cove (e.), Canning Canal (x.), [S.], (p. 197.)

Polinices plumbea, Lamarek (C.). *Locality*—Peppermint Grove, Minim Cove, Perth Water, Melville Water (r.), [R.]. *Recorded from King George's Sd.*

Polinices conicus, Lamarek (C.). *Locality*—Peppermint Grove and Minim Cove (m.c.), [R.]. *Recorded from Swan R., Geraldton, Mast Head Reef (Queensland), Thursday Is.*

Tonna variegata, Lamarek (M.). *Locality*—Rottneest (x.), [S.]. *Recorded from Geraldton, West Bight (100 fathoms), Mast Head Reef (Q.), (p. 196).*

Strombus pacificus, Swainson (M.). *Locality*—Fremantle (x.), [S.], (p. 193.)

Strombus australia, Sowerby (C.). *Locality*—Minim Cove (x.), [R.]. *Recorded from Nicol Bay and Rowley Shoals, (p. 192.)*

Oliva australis, DuRoi (M.). *Locality*—Minim Cove (x.), [S.]. *Recorded from Geraldton and New Guinea (p. 202.)*

Cypraea caputserpentis, Linne. (M.). *Locality*—Fremantle (x.), [S.]. *Recorded from Garden and Rottneest Is., Geraldton, Monte Bello Is., and New Guinea.*

Conus anemone, Lamarek (M.). *Locality*—Minim Cove (x.), Fremantle (x.), [S.]. *Recorded from Swan R., Geraldton, Monte Bello Is., N.-W. Australia, Tasmania (p. 205.)*

Conus pontificalis, Lamarek (M.). *Locality*—Minim Cove (x.), [S.]. *Recorded from Monte Bello Is. and Exmouth Gulf.*

Collonia modesta, [R.]. *Locality*—Peppermint Grove (r.), [R.].

Marginella, sp. [R.]. *Locality*—Minim Cove (r.), [R.]. (p. 203.)

Mitra glabra, Swainson (M.). *Locality*—Minim Cove (x.), Fremantle (x.), [S.]. *Recorded from King George's Sound (p. 208.)*

Cantharus undosus, Linne sp. (C.). *Locality*—Minim Cove (x.), [R.]. *Recorded from Geraldton.*

Cantharus, sp. [R.]. *Locality*—Minim Cove (c.), [R.].

Triton, sp. [R.]. *Locality*—Minim Cove (r.) [R.].

Cominella tasmanica, Ten. Woods (M.). *Locality*—Rottneest (x.), [S.]. *Recorded from King George's Sound and Tasmania (p. 209).*

Arcularia burchardi, Dunker (M.). *Locality*—Peppermint Grove (c.), Minim Cove (x.), Perth Water (r.), Melville Water (c.), [S.].

Arcularia victoriana, Iredale (M.). *Locality*—Perth and Melville Waters (r.), Rottneest (x.), [S.]

Arcularia rufula, Kiener (M.). *Locality*—Rottnest (x.), [S.].
Recorded from Swan R.

Purpura aegrota, Reeve (M.). *Locality*—Fremantle (x.), [S.].

Purpura, sp. [R.]. *Locality*—Peppermint Grove (r.), [R.],
Fremantle (x.), (p. 214.)

Siphonaria, sp. [C.]. *Locality*—Minim Cove (r.), [R.]. (p.
215).

Salinator fragilis, Q. & G. (C.). *Locality*—Minim Cove (c.),
[R.]. *Recorded from King George's Sound* (p. 214).

Marinula xanthostoma, H. & A. Adams, sp. (C.). *Locality*—
Peppermint Grove (r.), [R.]. *Recorded from Fremantle and Cos-
sack* (p. 215.)

Plecotrema binneyi, Crosse and Fischer (C.). *Locality*—Minim
Cove (m.c.), [R.]. *Recorded from Shark's Bay*, (p. 215.).

Auricula, sp. [R.]. *Locality*—Minim Cove (r.), [R.].

Bullaria botanica, Hedley, 1918 (—*B. australis*, Gray), (C.).
Locality—Peppermint Grove and Minim Cove (m.c.), [R.]. *Record-
ed from King George's Sound and Geraldton* (p. 221.)

Bullaria botanica, Hedley (C.). *Locality*—Minim Cove (x.),
[R.]. *Recorded from King George's Sound and Geraldton*.

Bullaria, sp. [R.]. *Locality*—Minim Cove (r.), [R.].

Cylichna arachis, Q. & G. [M.]. *Locality*—Peppermint Grove
(m.c.), Minim Cove (m.c.), Perth Water (c.), Melville Water (c.),
Canning Canal (c.), [S.]. *Recorded from King George's Sound
and Mast Head Reef* (Q.).

Bulla, sp. (M.). *Locality*—Fremantle (x.).

Class, SCAPHOPODA.

Dentalium, sp. [M.]. *Locality*—Peppermint Grove (r.), Minim
Cove (r.), Melville Water (r.), [S.].

INDEX TO LOCALITIES.

(Lat. S. and Long E.).

Canning R., 32° 115° 45'.	Mast Head Reef, 23°, 30' 151° 30'.
Carnac Is., 32° 11', 115° 42'.	Monte Bello Is., 20° 39', 115° 35'.
Cossack, 20° 40', 117° 8'.	Murray Is., 9° 50', 144° 50'.
Cleveland B., 27° 33', 153° 19'.	New Guinea, 9° 30', 149° 0'.
Dirk Hartog Is., 25° 47', 113° 0'.	Nicol Bay, 20° 40', 116° 40'.
Exmouth G., 22°, 114° 15'.	Pt. Adelaide, 34° 38', 138° 46'.
Fremantle, 32° 2', 115° 47'.	Rottneest Is., 32° 0', 115° 30'.
Garden Is., 32° 11', 115° 42'.	Sharks Bay, 25° 10', 113° 30'.
Geraldton 28° 44', 114° 40'.	Swan R., 32°, 115° 45'.
Irwin R., 29° 11', 115° 53'.	Sydney, 33° 52', 151° 11'.
King George's Sd., 35° 3', 117° 55'.	Timor, 9°, 125°.
	Thursday Is., 10° 30', 142° 12'.

SUMMARY AND CONCLUSIONS.

Of the 129 species listed in the last section, record of the geographical distribution of 56 only has been found by the writer. Of these 56, 22 have not been found south of Geraldton, 17 are of wide range and 17 are not recorded north of Geraldton. From these figures it would seem that there is a balance of evidence in favour of recent cooling of the water in the latitude of Perth.

Since reading this paper the writer has noticed the occurrence of fairly well defined fossiliferous zones in the shell beds, and a broad observation of the fauna in these zones has led to the opinion that in all probability there has been alternation of warm and cool waters during the deposition of the beds. This point would form the basis of profitable investigations in the district, and the matter of Quaternary climates be, thus, further cleared up.

The writer would like to state in conclusion, that criticism of this paper, more particularly of the nomenclature and classification, will be welcome.

